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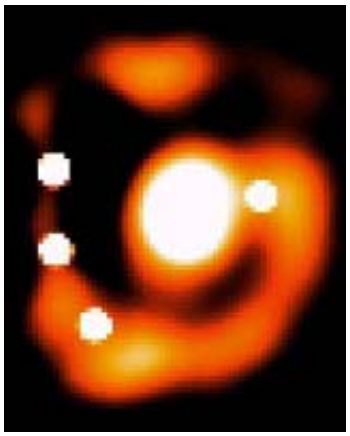
SPACE SCIENCE

Discovery Of Quadruply Lensed Quasar With Einstein Ring

Paris - Jul 18, 2003

Using the ESO 3.6-m telescope at La Silla (Chile), an international team of astronomers [1] has discovered a complex cosmic mirage in the southern constellation Crater (The Cup). This "gravitational lens" system consists of (at least) four images of the same quasar as well as a ring-shaped image of the galaxy in which the quasar reside - known as an "Einstein ring". The more nearby lensing galaxy that causes this intriguing optical illusion is also well visible.



Deconvolution image sharpening allows a better view of the four star-like components (the four images of the same distant quasar), the Einstein ring (the elongated image of the quasar's host galaxy) and the lensing galaxy (the central bright diffuse image).

- More images

The team obtained spectra of these objects with the new EMMI camera mounted on the ESO 3.5-m New Technology Telescope (NTT), also at the La Silla observatory. They find that the lensed quasar [2] is located at a distance of 6,300 million light-years (its "redshift" is z = 0.66 [3]) while the lensing elliptical galaxy is rougly halfway between the quasar and us, at a distance of 3,500 million light-years (z = 0.3).

The system has been designated RXS J1131-1231 - it is the closest gravitationally lensed quasar discovered so far.

Cosmic mirages

The physical principle behind a "gravitational lens"

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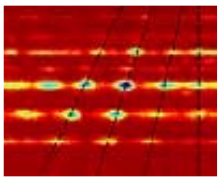

Los Alamos - Jul 25, 2003

Quick now, who holds the land-speed record for sending data over the Internet? If you pulled out your Guinness World Records book and said Los Alamos National Laboratory, you might earn a pint of the dark brew for which the donnybrook-deciding tome is named.

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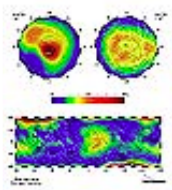

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"Breathtaking" new maps of likely sites of water on Mars showcase their association with geologic features such as Vallis Marineris, the largest canyon in the solar system.

ROCKET SCIENCE

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Los Angeles - Jul 25, 2003

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(also known as a "cosmic mirage") has been known since 1916 as a consequence of Albert Einstein's Theory of General Relativity. The gravitational field of a massive object curves the local geometry of the Universe, so light rays passing close to the object are bent (like a "straight line" on the surface of the Earth is necessarily curved because of the curvature of the Earth's surface).

This effect was first observed by astronomers in 1919 during a total solar eclipse. Accurate positional measurements of stars seen in the dark sky near the eclipsed Sun indicated an apparent displacement in the direction opposite to the Sun, about as much as predicted by Einstein's theory.

The effect is due to the gravitational attraction of the stellar photons when they pass near the Sun on their way to us. This was a direct confirmation of an entirely new phenomenon and it represented a milestone in physics.

In the 1930's, astronomer Fritz Zwicky (1898 - 1974), of Swiss nationality and working at the Mount Wilson Observatory in California, realised that the same effect may also happen far out in space where galaxies and large galaxy clusters may be sufficiently compact and massive to bend the light from even more distant objects.

However, it was only five decades later, in 1979, that his ideas were observationally confirmed when the first example of a cosmic mirage was discovered (as two images of the same distant quasar).

Cosmic mirages are generally seen as multiple images of a single quasar [2], lensed by a galaxy located between the quasar and us. The number and the shape of the images of the quasar depends on the relative positions of the quasar, the lensing galaxy and us.

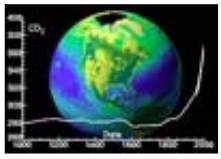
Moreover, if the alignment were perfect, we would also see a ring-shaped image around the lensing object. Such "Einstein rings" are very rare, though, and have only been observed in a very few cases.

Another particular interest of the gravitational lensing effect is that it may not only result in double or

An approach and landing test version of the X-37, a spacecraft designed to demonstrate technologies for NASA's Orbital Space Plane Program, successfully completed structural testing in Huntington Beach, Calif.

TERRADAILY

Future Droughts Could Leave Recent Dry Spells in the Dust



Los Angeles - Jul 18, 2003
Canada's Saskatchewan River system, which recently experienced its worse drought in 134 years, may be prone to more prolonged and severe droughts than previously thought, suggests a new UCLA study based on tree rings that are more than 1,000 years old.

TECH SPACE

Space Elevators Maybe Closer To Reality Than Imagined

Los Angeles - Jul 22, 2003
Space elevators have an image problem, mainly due to two prominent science fiction novels. They appear either ungainly impossible, or so potentially dangerous to the planet itself you would never dream of building one. With the science now indicating that they are potentially near-term transport systems, it's time to review the fiction in relation to the possible reality.

multiple images of the same object, but also that the brightness of these images increase significantly, just as it happens with an ordinary optical lens.

Distant galaxies and galaxy clusters may thereby act as "natural telescopes" which allow us to observe more distant objects that would otherwise have been too faint to be detected with currently available astronomical telescopes.

Image sharpening techniques resolve the cosmic mirage better

A new gravitational lens, designated RXS J1131-1231, was serendipitously discovered in May 2002 by Dominique Sluse, then a PhD student at ESO in Chile, while inspecting quasar images taken with the ESO 3.6-m telescope at the La Silla Observatory.

The discovery of this system profited from the good observational conditions prevailing at the time of the observations. From a simple visual inspection of these images, Sluse provisionally concluded that the system had four star-like (the lensed quasar images) and one diffuse (the lensing galaxy) component.

Because of the very small separation between the components, of the order of one arcsecond or less, and the unavoidable "blurring" effect caused by turbulence in the terrestrial atmosphere ("seeing"), the astronomers used sophisticated image-sharpening software to produce higher-resolution images on which precise brightness and positional measurements could then be performed (see also ESO PR 09/97).

This so-called "deconvolution" technique makes it possible to visualize this complex system much better and, in particular, to confirm and render more conspicuous the associated Einstein ring, cf. PR Photo 20a/03.

Identification of the source and of the lens

The team of astronomers [1] then used the ESO 3.5-m New Technology Telescope (NTT) at La Silla to obtain spectra of the individual image components of this lensing system. This is imperative because, like human fingerprints, the spectra allow unambiguous identification of the observed objects.

Nevertheless, this is not an easy task because the

different images of the cosmic mirage are located very close to each other in the sky and the best possible conditions are needed to obtain clean and well separated spectra.

However, the excellent optical quality of the NTT combined with reasonably good seeing conditions (about 0.7 arcsecond) enabled the astronomers to detect the "spectral fingerprints" of both the source and the object acting as a lens, cf. ESO PR Photo 20b/03.

The evaluation of the spectra showed that the background source is a quasar with a redshift of z = 0.66 [3], corresponding to a distance of about 6,300 million light-years. The light from this quasar is lensed by a massive elliptical galaxy with a redshift z = 0.3, i.e. at a distance of 3,500 million light-years or about halfway between the quasar and us. It is the nearest gravitationally lensed quasar known to date.

Because of the specific geometry of the lens and the position of the lensing galaxy, it is possible to show that the light from the extended galaxy in which the quasar is located should also be lensed and become visible as a ring-shaped image. That this is indeed the case is demonstrated by PR Photo 20a/03 which clearly shows the presence of such an "Einstein ring", surrounding the image of the more nearby lensing galaxy.

Micro lensing within macro lensing?
The particular configuration of the individual lensed images observed in this system has enabled the astronomers to produce a detailed model of the system. From this, they can then make predictions about the relative brightness of the various lensed images.

Somewhat unexpectedly, they found that the predicted brightnesses of the three brightest star-like images of the quasar are not in agreement with the observed ones - one of them turns out to be one magnitude (that is, a factor of 2.5) brighter than expected. This prediction does not call into question General Relativity but suggests that another effect is at work in this system.

The hypothesis advanced by the team is that one of the images is subject to "microlensing". This effect is

of the same nature as the cosmic mirage

- multiple amplified images of the object are formed - but in this case, additional light-ray deflection is caused by a single star (or several stars) within the lensing galaxy. The result is that there are additional (unresolved) images of the quasar within one of the macro-lensed images.

The outcome is an "over-amplification" of this particular image. Whether this is really so will soon be tested by means of new observations of this gravitational lens system with the ESO Very Large Telescope (VLT) at Paranal (Chile) and also with the Very Large Array (VLA) radio observatory in New Mexico (USA).

Outlook

Until now, 62 multiple-imaged quasars have been discovered, in most cases showing 2 or 4 images of the same quasar. The presence of elongated images of the quasar and, in particular, of ring-like images is often observed at radio wavelengths. However, this remains a rare phenomenon in the optical domain - only four such systems have been imaged by optical/ infrared telecopes until now.

The complex and comparatively bright system RXS J1131-1231 now discovered is a unique astrophysical laboratory. Its rare characteristics (e.g., brightness, presence of a ring-shaped image, small redshift, X-ray and radio emission, visible lens, ...) will now enable the astronomers to study the properties of the lensing galaxy, including its stellar content, structure and mass distribution in great detail, and to probe the source morphology.

These studies will use new observations which are currently being obtained with the VLT at Paranal, with the VLA radio interferometer in New Mexico and with the Hubble Space Telescope.

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SPACE SCIENCE

Gravity Probe B Arrives At Vandenberg
Vandenberg AFB - Jul 16, 2003

The NASA spacecraft designed to test two important predictions of Albert Einstein's Theory of General Relativity was shipped yesterday from the Lockheed Martin Space Systems Facility in Sunnyvale, Calif., to the launch site at Vandenberg Air Force Base, Calif., after completing environmental testing.